Report for 2001NC1441B: Effect of Riparian Buffers on Removal of Nutrients and Sediment in Urban Streams

There are no reported publications resulting from this project.

Report Follows:

Problem and Research Objectives:

Riparian buffer zones in urban streams are important in the protection and restoration of water quality, especially nutrient and sediment removal. The specific benefits of buffers vary with local conditions, such as vegetation type and structure, and soil physical and chemical properties. Management of vegetation within riparian buffer zones in urban areas is constrained by many conflicting needs, and management concern for improving urban water quality is recent. However, there is no scientific consensus or set of guidelines on the benefits of buffers of different types, thus, managers are further constrained in their efforts to resolve conflicting needs.

Urban streams in the Piedmont of North Carolina are characterized by poor water quality, high sedimentation, and impaired biotic habitat. Most are on the 303d list. To improve water quality the City of Greensboro is instituting a large-scale effort to develop vegetated riparian buffers. However, the site-specific parameters for maximum buffering capacity for nutrient and sediment removal are unknown

This project was designed to isolate the effect of vegetation type on the quality of water passing through riparian buffers in an urban stream. Of the many aspects of riparian zones that can affect water quality, we chose to focus our initial efforts on the impact of vegetation types on stream water quality. The specific objectives of this research were:

a. To determine the effect of vegetation type within riparian buffer zones on surface runoff water quality.
b. To determine the effect of riparian vegetation type on sub-surface water quality.
c. To experimentally evaluate loss of nutrient tracers moving across riparian zones of different composition.
d. To incorporate field experimental and comparative data into a GIS database for future development of a predictive model of the effects of riparian buffer development on quality of water discharging into the Upper Cape Fear River Basin.

This research will contribute to our ultimate long-term goal, not expected to be completed during this initial project, which is to develop a comprehensive GIS-based predictive model for buffer effectiveness across land-use types, soil characteristics, topographical features and site-specific hydrological conditions for the Upper Cape Fear Watershed.

Methodology:

Sites, Treatment, and Sampling: The Buffalo Creek riparian zones within the City of Greensboro NC (Guilford County) was the study site. Two vegetation types were represented which had sufficient width to conduct the experiment: forested and grassy. We selected several possible sites based on slope and width of the riparian buffer zones using GIS generated broad-scale 2-ft contour maps overlaid on the aerial photos. Then, we examined these sites in the field and selected 6 experimental sites (3 in forested and 3 in grassy). At each site, 5 sampling locations were determined at 50-m, 30-m, 20-m, 10-m and 1-m distance from the stream. The sampling locations follow the general flow path of water runoff. To collect sub-surface water, two lysimeters, 20-cm deep and 50-cm deep, were installed at each sampling location. Two wells of 1.5 meter deep were also

installed at the upslope edge and near the stream at each of the study site for collecting deeper soil water samples. Soils were examined, and slopes, aspects were measured.

We applied one treatment for each site each season. For each site, we applied 6,500 gallons of nutrient solution (NO3-14ppm, NH4-8ppm, P2O5-6.5ppm) from a 3-meter long spreader at an application rate of 55-65 gallons (210-250 liters)/minute. The N content of the solution was 3X the concentration of the highest storm water N concentration measured in the city. The duration of the treatment (starting and ending of the nutrient solution application) and the ending surface runoff were recorded. Soil samples were collected for examining soil water content before each treatment.

One day (24 hr) prior to the treatment, the lysimeters were pumped. Water samples were collected from the lysimeters immediately before treatment. During treatment, surface runoff samples were collected at each sampling location as soon as the runoff reached that point. 24-hr after each treatment, lysimeters were sampled and pumped dry. An additional set of samples was collected from the lysimeters 12-18 hours later. Well and stream water samples were collected the same time as lysimeter samples.

Each season, we also collected lysimeter and well samples after one medium-heavy precipitation event (> 20 mm). The lysimeters and wells were pumped 12-hr after the rain event, sampled, re-pumped, then re-sampled 12-18 hours later.

For all sampling, water samples were immediately placed in a cooler, brought to the lab, and stored in the freezer until they were analyzed. Nutrient concentrations were analyzed with a Bran-Luebbe TRAACS 2000 auto-analyzer. Soil water contents were examined following standard methods.

Data Analyses: ANOVA is being used to evaluate the impact of two types of vegetated riparian on water quality mediation.

Table 1: Variable Summary of the Data Collected in this Study (reps=3)

Variable:	**samples**
Distance to stream:	1m, 10m, 20m, 30m, 50m,
Depth of water samples:	0 cm (surface runoff), 20cm, 50cm, 1.5m (well)
Seasons:	2001-winter, 2002-spring, 2002-summer, 2002-fall
Sample time:	pre-treatment, 1-day, and 2-day pos-treatment,
Riparian Vegetation Type:	forest, grass
Watering Events:	treatment (nutrient solution application), natural rain

Principle Findings and Significance (progress report):

Due to start-up delays, the first treatment occurred in the 2001-2002 winter season. We have completed winter, spring, and summer treatments and associated sampling, and three sets of sampling of natural rain events (winter, spring, and summer). The field sampling will be completed in 2002 fall season. The following are the work elements we have accomplished:

May 9, 2001 – June 1, 2001

- Ordering supplies
- Construction of lysimeters.

June 2, 2001 – Sep 1, 2001

- Construction of lysimeters and surface water collectors continued.
- Continued purchase of supplies.

- Refinement of field site selection.
- Begin field installation of lysimeters and surface water collectors at field sites.

Sep 2, 2001 – Dec 1, 2001

- Train students in use of the auto-analyzer. Considerable effort was expended in getting it calibrated and running for local water chemistry.
- Conduct preliminary experiment. This preliminary experiment provided essential information for making modifications to the experimental design (see methodology)

Dec. 2, 2001 – June 30, 2002

- Conducting winter, spring, and summer treatments and sampling (~500 samples collected each time).
- Sampling after natural rain events (once each season, ~300 samples collected each time).
- Sample analyses (40% of collected samples have analyzed)
- Design statistical model for data analyses (5% of the task has been finished)

The preliminary data indicate that the overall approach and design have been successful. At this moment, we may conclude that:1) forested riparian zone has stronger hydrological buffering capacity than grassy riparian; 2) topographical relief affects surface runoff; 3) riparian soils effectively buffer NH4, but have little impact on NO3; 4) riparian width greatly affects water quality of sub-surface runoff, but has little impact on that of surface runoff; 5) impact of riparian width on surface runoff is through soil infiltration that reduces amount of surface runoff and its flux.